

CLAIMS

1. A plant expressing a cell wall UCP encoded by a heterologous UCP gene.
- 5 2. The plant of claim 1, wherein the heterologous UCP gene comprises a gene encoding UCP2.
3. The plant of claim 1, wherein the heterologous UCP gene is a gene selected from the group consisting of a gene encoding UCP1, UCP3, UCP4, UCP5, and UCP6.
- 10 4. The plant of claim 1, wherein the heterologous UCP gene comprises a gene encoding PUMP.
5. The plant of claim 1, wherein the heterologous UCP gene comprises a gene
15 encoding StUCP.
6. The plant of claim 1, wherein the heterologous UCP gene comprises a gene encoding AtPUMP.
- 20 7. A method for regulating fuel metabolism in a plant, comprising,
regulating UCP expression in a plant cell wall/ plasma membrane or chloroplast to regulate fuel metabolism of the plant.
8. The method of claim 7, wherein the method involves increasing the expression
25 or activity of UCP in the plant cell wall/ plasma membrane or chloroplast.
9. The method of claim 8, wherein the expression or activity of UCP in the plant cell wall/ plasma membrane or chloroplast is increased by introducing into the plant cell an expression vector including a gene encoding a heterologous UCP.

10. The method of claim 8, wherein the expression of activity of UCP in the plant cell wall/ plasma membrane or chloroplast is increased by stably transforming the plant cell with an expression vector including a gene encoding a heterologous UCP.

5 11. The method of claim 9 or 10, wherein the heterologous UCP gene is a gene selected from the group consisting of a gene encoding UCP1, UCP2, UCP3, UCP4, UCP5, and UCP6.

10 12. The method of claim 9 or 10, wherein the heterologous UCP gene is a gene selected from the group consisting of a gene encoding PUMP, StUCP, and AtPUMP.

15 13. The method of claim 8, wherein the expression or activity of UCP in the plant cell wall/ plasma membrane or chloroplast is increased by contacting the plant with a UCP activator.

20 14. The method of claim 13, wherein the cell wall UCP activator is a compound selected from the group consisting of sugars including but not limited to glucose, sucrose, maltose, and dextrose, structural analogs of sugars including but not limited to glucose, sucrose, maltose, and dextrose, inhibitors of nucleotides and nucleotide analogs, omega 3 fatty acids, omega 6 fatty acids, and norflurazon.

25 15. The method of claim 8, wherein the expression of UCP in the cell wall/plasma membrane is increased by contacting the plant with a cell wall targeted UCP molecule.

30 16. The method of claim 15, wherein the cell wall targeted UCP molecule is a UCP molecule linked to a targeting molecule selected from the group consisting of glucose transporters, sucrose transporters, maltose transporters, and fatty acid transporters.

 17. The method of claim 8, wherein the expression of UCP in the chloroplast is increased by contacting the plant with a chloroplast targeted UCP molecule.

18. The method of claim 17, wherein the chloroplast targeted UCP molecule is a UCP molecule linked to a targeting molecule selected from the group consisting of a chloroplast transit protein and a peptide of N terminus small subunit of ribulose 5-phosphate carboxylase.

19. The method of claim 8, wherein the expression of UCP in the cell wall/plasma membrane, is increased by contacting the plant with a plasma membrane targeted UCP molecule.

20. The method of claim 19, wherein plasma membrane targeted UCP molecule is a UCP molecule linked to a targeting molecule which is plant specific membrane targeting sequence lacking a VSS or KDEL sequence.

21. The method of claim 8, wherein the expression of UCP in the cell wall/plasma membrane is increased by contacting the plant with a plasma desmata targeted UCP molecule.

22. The method of claim 21, wherein the plasma desmata targeted UCP molecule is a UCP molecule linked to a plasma desmata targeting molecule which is a porin-like targeting sequences.

23. The method of claim 8, wherein the expression of UCP in the cell wall/plasma membrane is increased by contacting the plant with a pore targeted UCP molecule.

24. The method of claim 23, wherein the pore targeted UCP molecule is a UCP molecule linked to a targeting molecule selected from the group consisting of a porin peptide, a VSS tail and a KDEL tail.

25. The method of claim 7, wherein the method involves decreasing the expression or activity of UCP in the plant cell wall/ plasma membrane or chloroplast.

26. The method of claim 25 wherein the expression or activity of UCP in the plant cell wall/ plasma membrane or chloroplast is decreased by contacting the plant with a UCP inhibitor.

5

27. The method of claim 26, wherein the cell wall UCP inhibitor is a compound selected from the group consisting of UCP binding peptides such as anti-UCP antibodies, UCP anti-sense nucleic acids, UCP dominant-negative nucleic acids, nucleotides, nucleotide analogs tocopherols, and non-omega-3, -6 fatty acids.

10

28. An expression system, comprising:

a promoter sequence,

a first structural gene encoding a heterologous UCP and a second structural gene encoding a plant cell wall targeting peptide or a chloroplast targeting peptide, the first and second structural genes arranged to form a fusion protein and operably linked to and under the control of the promoter sequence.

15

29. The expression system of claim 28, wherein the promoter sequence is a plant specific promoter.

20

30. The expression system of claim 28, wherein the UCP encoded by the first structural gene is a mammalian UCP.

31. The expression system of claim 28, wherein the UCP encoded by the first structural gene is a plant UCP.

25

32. A plant stably transformed with the expression system of claim 28.

33. A seed of the plant of claim 32.

30

34. A progeny, clone, cell line or cell of the plant of claim 32.

35 A transgenic plant transformed with a nucleic acid construct comprising a nucleic acid sequence encoding a UCP operably linked to a promoter sequence, wherein the nucleic acid contract also encodes a plant cell wall targeting peptide or a chloroplast targeting peptide.

5

36. A seed of the transgenic plant of claim 35.

37. A progeny, clone, cell line or cell of the transgenic plant of claim 35.

10

38. A method for producing a nutritionally enhanced plant, comprising:
decreasing the expression or activity of UCP in the plant cell wall/ plasma
membrane or chloroplast to produce a nutritionally enhanced plant.

15

39. The method of claim 38, wherein the expression or activity of UCP in the
plant cell wall/ plasma membrane or chloroplast is decreased by contacting the plant with
a UCP inhibitor.

20

40. The method of claim 38 wherein the UCP inhibitor is a chloroplast or cell
wall UCP antisense sequence.

41. A plant produced by the method of claim 38.

42. A method for improving the light and cold sensitivity of a plant, comprising:
increasing the expression or activity of UCP in the plant cell wall/ plasma
25 membrane or chloroplast to improve the light and cold sensitivity of the plant.

30

43. The method of claim 42, wherein the expression or activity of UCP in the
plant cell wall/ plasma membrane or chloroplast is increased by introducing into the
plant cell an expression vector including a gene encoding a heterologous UCP.

44. The method of claim 43, wherein the expression of activity of UCP in the plant cell wall/ plasma membrane or chloroplast is increased by stably transforming the plant cell with an expression vector including a gene encoding a heterologous UCP.

5 45. The method of claim 43, wherein the heterologous UCP gene is a gene selected from the group consisting of a gene encoding UCP1, UCP2, UCP3, and UCP4.

 46. The method of claim 43, wherein the heterologous UCP gene is a gene selected from the group consisting of a gene encoding PUMP, StUCP, and AtPUMP.

10

 47. The method of claim 42, wherein the expression or activity of UCP in the plant cell wall/ plasma membrane or chloroplast is increased by contacting the plant with a UCP activator.

15 48. The method of claim 42, wherein the expression of UCP in the plant cell wall/ plasma membrane or chloroplast is increased by contacting the plant with a UCP molecule.

 49. A method for preventing an infection in a plant, comprising:
20 decreasing the expression or activity of UCP in the plant cell wall/ plasma membrane or chloroplast in an amount to prevent an increase in oxygen free radicals and to prevent infection in the plant.

44
45
46
47
48
49